

# **A phylogenetic analysis of truncated hemoglobins. Functional diversity in cyanobacteria.**

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Truncated hemoglobins (trHbs) are heme proteins found in bacteria, plants, and unicellular eukaryotes. Four species of cyanobacteria have been found to contain one or two trHb genes. In *Nostoc commune* the protein appears essential for protecting the nitrogen fixation complex from oxidative damage. *Nostoc punctiforme* has an identical trHb that is presumed to serve the same function. However, the other two cyanobacteria that contain a trHb gene do not fix nitrogen. The present work reports on a trHb phylogenetic analysis completed with a data set of 109 sequences. It was confirmed that the trHb group breaks down into three distinct subgroups. These were found to comprise orthologs, whereas the members of each subgroup were paralogous across the subgroups. Although all the cyanobacteria were located in one of the three main branches, the non-nitrogen fixing cyanobacteria were clustered with eukaryotes and protobacteria. The nitrogen fixers were outliers to this cluster. This clustering pattern coincided with differences in primary structure at positions that have been shown to modulate ligand affinity. The phylogenetic analysis of the trHb genes stands to reveal further meaningful information about the history of nitrogen fixation and oxygen use in cyanobacteria. Non-cyanobacterial trHbs are suspected to play distinct roles in algal photosynthesis and environmental adaptation in certain pathogens. Analysis of the relationship among all trHbs will yield a refined understanding of hemoglobin evolution. Supported by NSF grant MCB-0349409 and NASA grant NNG04GN33H.